

II

THE DEVELOPMENT OF THE INDIVIDUAL

IT is not necessary to explore what Shakespeare called "the dark backward and abysm of time" in order to see man in the process of his becoming. Evolution or phylogeny helps us to see him in proper perspective against the immensity of time and space and the vast processes of life on the earth, but for close and accurate observation the development of the individual or ontogeny offers opportunities for exact and even experimental study that can never be equalled by any exploration of the course of evolution in past ages of the earth's history.

In the development of the individual we can see and study the exact stages of such becoming, and the causes or factors that are involved. These factors of development are of two general classes, those that lie within the organism and those that come from outside; in the main, the former are known as heredity, the latter as environment, or in "the jingle of words" proposed by Francis Galton, they are Nature and Nurture. The former of these factors of development are found in the constitution of the germ cells from which every individual develops, the latter in the conditions and stimuli which act upon this germinal organization in the course of its transformation into the mature organism.

1. THE AMAZING FACTS OF DEVELOPMENT

It is a curious and interesting fact that philosophers generally consider man only in the full epiphany of his powers,

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and forget or disregard the steps by which he has reached this high estate. And yet nothing is more universally evident than the process of development. Every person in the world, indeed, every animal and plant except possibly the very lowest, has come into existence by this method of development. I never see a great crowd of people without thinking that each and every one of them was once a child, an infant, an embryo, an egg cell—that every human being was born of woman. A professor of gynecology in one of our medical schools used to hold up before his classes the skeleton of a female pelvis and say, "Gentlemen, here is the triumphal arch through which every mother's son has come into the world." We generally think of illustrious persons as if they had always been illustrious, forgetting that every one of them was once a child and thought as a child, and before that a baby, an embryo, a germ cell, and behaved as a baby, an embryo, and a germ cell.

The mere fact of such development is so marvellous that it would seem incredible were it not so universally evident. The development of a human being, of a great personality, from a germ cell is surely the climax of all wonders, and yet it is so common that it has ceased to excite wonder. The principal steps or stages of development are known for thousands of species of animals and plants and enough is known of human development to be certain that in all essential respects it resembles that of other animals and especially that of higher mammals. We know that the entire person—structures and functions, organs and their uses, sense organs and nervous system, tropisms and instincts, sensations and emotions, memory and intelligence—in short, all physical and psychical characteristics, are the products of development. Furthermore, structures and functions, body and mind, develop together as a single indivisible unity.

This is a conclusion of such vast philosophical importance that it cannot be overemphasized. There is no possibility of denying the reality of such development, and the very fact that psychical qualities as well as physical ones develop out of a germinal condition will, if squarely faced, upset whole systems of philosophy and theology.

2. THEORIES OF DEVELOPMENT

When the disturbing implications of personal development began to be appreciated in the eighteenth century there arose a school of naturalist-philosophers who attempted to solve all of these difficulties by denying the fact of development. "There is no becoming," said the physiologist Haller, all things being present in miniature in the germ. What seemed like development was said to be only growth and unfolding or "evolutio." The little plant, root and stem and leaves, could be seen in the seed, and with poor microscopes and good imaginations it was said that the little man, the "homunculus," head and limbs and all, could be seen in the human sperm; and finally it was maintained that generation inside generation to the end of the species was packed away in the germ cells of the first parents.

This absurd and impossible conclusion was challenged and finally overthrown by an appeal to the actual development of the germ. Caspar Friedrich Wolff, in 1759, showed that in the earliest stages of seeds and eggs there was no little plant or animal, but only semi-fluid globules (cells) which gradually took the form of layers, membranes, and organs. Development in the sense of transformation and new formation was therefore a fact, and was something more than the mere unfolding of a preformed organism. Indeed, it was assumed that at the beginning of development the germ was absolutely simple, if not unorganized, and

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that mysterious formative and directive forces ("*nisus formativus*" and "*vis directrix*") acted upon the germ and caused it to develop in a specific way. Thus development was, as it were, built on the germ from without, and therefore this theory was called *epigenesis*. The old view of preformation assumed genesis from within and might therefore be called *endogenesis*.

There is no doubt that epigenesis more nearly corresponds to the facts of development than preformation, but there are elements of truth in both of these theories, and errors in the extreme views of each. The germ is not a mature animal in miniature, nor is it wholly lacking in substances and parts that guide and direct development. The complex egg cell is transformed into the still more complex adult by environmental stimuli acting on its intrinsic constitution; both epigenesis and endogenesis are involved in development.

Development is a fact, both body and mind develop, and this fact must be reckoned with by all present systems of philosophy. Although body and mind develop together, all structures and functions do not develop at the same rate; some come to maturity early, others late, and all succeeding stages are influenced by, and dependent on, preceding ones. Some structures and functions are of only temporary value, and then give way to, or are transformed into, parts and functions of more lasting service, until the final adult structures and functions are attained. But, at every step, structure and function are inseparable in any living thing, every living structure has its function, every function its structure at every stage in development.

Although structure and function, body and mind, develop together, it will be convenient to deal with them separately, and we begin with the development of the body. In all ani-

imals and plants development begins in a single cell, the egg or female sex cell. It was once thought that this cell was very simple, a mere mass of mucus, mucilage, or living jelly. Even as late as 1874, the distinguished German embryologist, Alexander Goette, maintained that the egg of the toad "is neither in whole nor in part a living organism," but is a mass of non-living material which is stimulated into life by the entrance of the spermatozoon.¹ At the beginning of this century the work of Jacques Loeb on "chemical fertilization," or what is now called artificial parthenogenesis, led many persons to conclude that the egg became alive under the action of salt solutions. Of course such conclusions were absurd. Eggs are as truly alive as are mature animals. But although they are as truly alive, they are not as complexly alive, but are relatively simple as compared with adults. In the egg cell from which a man develops we have human life reduced to its simplest terms, and it is because life structures and functions are here reduced to their simplest terms that the study of the egg and its development is so fascinating.

3. THE MECHANISM OF DIFFERENTIATION

Every cell, whether egg or sperm or tissue cell, consists of at least two distinct portions, a central body, the nucleus, and the surrounding cell substance, or cytoplasm. Each of these consists of several different parts only a few of which need be mentioned here. Both nucleus and cytoplasm are differentiations of protoplasm, the living substance; but in addition to this living, or formative material, there are many other substances in the cell that are not living in the same sense or degree as protoplasm, for there are various stages or degrees of living. These other substances are

¹A. Goette, *Entwicklungs Geschichte der Unke*, pp. 35, 77.

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called collectively metaplast, and many different kinds of metaplast are formed in the course of development.

The nucleus is a compound structure consisting of a specific number of chromosomal vesicles which form compartments or segments of the whole nucleus. At the time of cell division, within each compartment arises a long thread or chromosome with a series of granules or chromomeres along the thread, like beads on a string. In the division of the nucleus and cell, each chromosome with its chromomeres splits lengthwise, the two halves separating to the two daughter cells, so that there is an exact halving of every chromosome and chromomere in this process of division, which is called mitosis.

This complicated method of division indicates that the chromosomes must be of great importance, and extensive study has shown that they are the seat of specific factors of heredity. Furthermore the remarkable work of Morgan and his associates has proved that these specific factors of heredity have definite locations along the length of each chromosome, similar to, but more numerous than, the chromomeres. These factors have been called genes, and there has been much speculation as to what they are and how they act, but at least it can be said that they are specific factors in the determination of particular hereditary characteristics, such as blue or brown eyes, curly or straight hair, etc.

Chromosomes and genes usually continue without fundamental change throughout all cell divisions, so that in the end every cell in the body may have the same constellation of chromosomes and genes. And yet these cells have become amazingly dissimilar; some are epithelia, glands, nerves, muscles, cartilage, bone, etc. How is it possible to explain this progressive cell differentiation when there is no pro-

gressive nuclear differentiation? Well, we know that while the nucleus always divides with exact equality, the cell body often divides very unequally. The cell body contains a variety of different substances, which are more or less localized in different parts of the cell, and, when the cell body divides, these substances often go into different daughter cells. Thus differences, or differentiations, arise among embryonic cells.

But in order to account for the amazing number of differentiations in the body of any animal, there must be a progressive *production* of different kinds of substances in the cell bodies as well as a differential *distribution* of these substances to the cells in division. How are these different substances produced, and how does heredity, that is how do the chromosomes, control this process of differentiation?

There is a continual interchange between the nucleus and the cell body. When the chromosomes are dividing, they are small, dense threads. Immediately after division they swell up by absorbing fluid from the cell body and become chromosomal vesicles, and all these vesicles crowded together make the spherical nucleus, which continues to absorb fluid from the cell body until the division stage is reached, when the nuclear membrane and the chromosomal vesicles dissolve, liberating the new chromosomes naked into the cell body, and at the same time setting free a large volume of granular fluid into the cytoplasm. In the cycle from one cell division to the next there is thus a period during which the chromosomes and chromosomal vesicles are taking in fluids by osmosis, and a period when by the dissolution of their membranes they set free into the cytoplasm large quantities of elaborated materials. These periods may be called the "diastole" and "systole" of the nucleus, and within the framework of this mechanism the hereditary control of differentiation takes place. It is not possible at

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present to follow all the details of this process, but its general outlines are clearly marked.

All differentiation occurs in the cell body, while the nucleus and genes do not undergo progressive differentiation in the course of development, but remain relatively unchanged throughout the whole life cycle. The nucleus with its chromosomes and genes is therefore the chief seat of the material basis of heredity; the cell body is the place where differentiation occurs.

The earliest differentiations of egg cells are relatively few but very fundamental. Even while the egg is growing in the ovary, there is usually a difference in the relative quantities of cytoplasm and yolk at the two poles on opposite sides of the egg. The axis connecting these poles is the chief axis, and it bears a definite relation to the chief axis of the body that develops from the egg. In some types of eggs bilateral symmetry or asymmetry is visible, and these become the bilaterality or asymmetry of the adult. Even the positions and proportions of some of the future organ systems, such as muscles, nervous system, notochord, gut, may be marked out in the egg by different kinds of cytoplasm. These different substances and their locations in the egg cell are the earliest visible differentiations of development.

Different phyla of animals have different types of eggs; for example, there are the echinoderm, the annelid, the molluscan, and the vertebrate types. Development begins and certain main features are determined in the egg before it is fertilized. Consequently the egg contributes more to development than the sperm does.

We are vertebrates because our mothers were vertebrates and produced eggs of the vertebrate type; but the color of our skin and hair and eyes, our sex, stature and mental peculiarities were determined by the sperm as well as by the egg from which we came.¹

¹Conklin, *Heredity and Environment*, Princeton University Press, 1915.

In most animals and plants the progressive differentiation of the egg ceases at an early stage unless it is entered and fertilized by a male sex cell or sperm. The sperm not only stimulates the egg to go on in its development, but it also brings into the egg a new group of chromosomes and their genes. Just as the differentiations of the egg before fertilization are controlled by genes in the egg nucleus, so the genes of both egg and sperm nuclei influence later differentiations after fertilization. The manner in which this influence of genes on cytoplasm is accomplished is not certainly known, but it seems probable that it is by means of certain enzymes or ferments which are formed by the genes and which then act on the cytoplasm to cause differentiations. Here is in bare outline the mechanism or machinery by which the hereditary factors, the genes, influence the cytoplasm of the egg so as to bring about the differentiations of development.

There are certain resemblances between the fundamental processes in the ontogeny and phylogeny of organisms and those involved in inorganic and cosmic evolution. All of these phenomena are forms of development, and in all there is the production of new substances and qualities, new structures and functions, by means of new combinations of pre-existing elements or units. So far as is now known, all the material substances in the universe are the products of different combinations of some ninety-two different kinds of chemical elements or atoms. Thus a relatively small number of different kinds of atoms gives rise to an inconceivably large number of different kinds of compounds. We have recently learned that the ninety-two different kinds of atoms are products of different combinations of a few identically similar protons, electrons, and possibly other subatomic units. In similar manner, different combinations

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of twenty-six letters of the alphabet produce an immense number of words, and different combinations of words give rise to whole literatures.

In each of these combinations of units, new qualities appear which were not present in the individual units, but are the results of the new combinations. The peculiar characteristics of the ninety-two different kinds of atoms, from the simplest, hydrogen, to the most complex, uranium, are not present in the protons and electrons, but result from ninety-two different combinations of these. The properties of the innumerable different chemical compounds in the universe are not present in the individual atoms and molecules that enter into their constitution, but are products of the innumerable combinations of these atoms and molecules. The homunculus does not exist already preformed in the germ cells, but the embryo results from the interaction of genes and cytoplasm, of cells and environments. Mind and consciousness are not present in the germ cells, but they are the new products of innumerable structures and functions that are differentiated and integrated in the course of development. The literatures of the world are not found in the individual words of which they are composed, nor the words in the individual letters, but always new characteristics appear in new combinations of units which do not show these qualities.

This general principle has been called "creative synthesis" (Spaulding), "creative evolution" (Bergson), "emergence" (Lloyd Morgan), and it is fundamental in all development, whether of an individual or a species. New combinations of atoms and molecules give rise to new kinds of genes and chromosomes and cytoplasms. New combinations of nuclear and cytoplasmic substances give rise to the innumerable kinds of substances formed in the process of differ-

entiation. Development is not a mere additive process, but a creative one. But typical development consists not only in the formation of new substances with new qualities, but also in the orderly localization and integration of these in the embryo. These localizations are brought about by flowing movements in the protoplasm by which different substances are carried to particular parts of the egg cell, and by means of cell division these substances are cut off in different cells. Different kinds of cells unite to form tissues, tissues to form organs, organs to form systems, and all these constitute the organism.

All these processes of differentiation, localization, and segregation of different substances, cells, and organs would result in dislocated or isolated organs and portions of the body if it were not for some principle of integration. This integration is secured at first by actual contact between different substances and structures within cells, and later by contact and interchange between different cells, but, as the number of cells and parts increases, the various parts are integrated by specialized nerve cells which connect all parts together; also by peculiar chemical substances, the hormones, which are formed in specialized and localized glands and are then distributed to all portions of the organism, where they serve to stimulate the activity of certain cells or to restrict the activity of others, and thus to preserve the integration of the organism. Much experimental work is being done on the integrations of development and the unity of the organism, but it is still a good deal of a mystery. We can understand some of its main features, but not its most significant details, e. g., it is clear that the contacts of cells, the connections of nerves, or the distribution of hormones provide the means for stimulation or inhibition, but how and why they act upon those particular cells where

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stimulus or inhibition is needed in order to control typical development—this is the mystery.

4. STRUCTURE AND FUNCTION

There can be no doubt that the fundamental causes of development, as well as its general course, are essentially the same in man and animals. This is true not only of bodily structures but also of functions or the uses of structures. Just as certain fundamental structures are present in the egg at the beginning of development, so also certain fundamental functions are present. Indeed, the egg is a living thing, and it has all the necessary functions of living things. First among these is the function of assimilation, or the capacity of converting certain foreign substances into its own substance, which power every living thing possesses. Everywhere the continuance of life depends upon assimilation, for the complex living material is continually being oxidized to less complex substances, and it would quickly be used up if it were not replaced by the incorporation of new material. Living always involves this oxidation or burning. "The flame of life" is no mere figure of speech; if it produced visible light we would all be shining beacons. The persistence, growth, and spread of living things depend first of all upon the capacity of living material to build foreign substance into its own substance. This is assimilation (making similar) of foreign substances to the living material.

As a result of assimilation, living matter grows, but never as one continuous mass, but rather as discontinuous masses, or individual units. The units of living matter which are found everywhere are cells, each of which grows to a certain maximal size and then divides, or ceases to continue to grow. In the same way, nuclei, chromosomes, genes have

the capacity of individual assimilation, growth, and division, and the same is true of certain units in the cytoplasm of cells. Indeed, assimilation, growth, and division are fundamental properties of all living units, and there is no better answer than this to the question, "Is this alive?" or to that more general question, "What is life?"

Other properties of living things, which are not always so evident, are often lumped together under the term irritability. But many non-living things are also irritable, that is, they respond to stimuli, as gunpowder responds to a spark, or the photographic plate to light. The irritability of living things is peculiar in that the responses to stimuli differ with different conditions, and especially because such responses are generally useful in that they are self-conserving. This irritability of living matter might better be called "differential sensitivity," and the usefulness of a response, "selective reactivity," for the organism appears to select from many possible responses those which tend to its self-preservation.

All of these basic functions are found in eggs and sperms as well as in other kinds of living cells; they are as characteristic of life as are the structures of protoplasm and cells; indeed they are more characteristic because they are more generally recognized. The usual method of determining whether an object is alive or not is by observing what it does—its functions rather than its structures. But functions and structures are inseparable in living things; they are merely two aspects of life, and may be compared with the two sides of a coin. Function is not the cause of structure, or *vice versa*, any more than one side of a coin is the cause of the other side; they are in fact two aspects of one thing.

One reason why this has not always been appreciated is the fact that the structures of a dead body seem to remain

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after the functions have ceased, but the structures of a dead body are not like the living structures. A large part of our bodies is not living, while other parts are alive; hair, nails, the outer skin, much of our teeth and bones and the larger part of the connective tissue which penetrates and binds together the various organs, are not really or fully alive. Only that relatively small part, the protoplasm of the living cells, is fully alive, and when death occurs it undergoes profound changes. Dead protoplasm does not have the same structure as living protoplasm; it undergoes coagulation and disorganization, and ceases to manifest the functions of living protoplasm. Thus structure and function are inseparable in living beings; where there are no living structures, there are no living functions, and *vice versa*. Furthermore, specific living functions are always associated with specific forms of protoplasm; the protoplasm of a gland or muscle or nerve cell is as specific as the functions of those cells, although it may not be so plainly visible. No postulate of biology is more certain than this, that the functions of life are inseparably associated with the structures of living matter.

This is a conclusion of the utmost importance in biology and philosophy. It does not mean that structure is the cause of function, nor that function is the cause of structure, but that in life neither can exist apart from the other. Probably no scientist or philosopher would deny that digestion is associated with the secretion of digestive cells, motion with the contraction of muscle cells, nerve reception and conduction with the structure of nerve cells, and sensory phenomena with sensory cells. But materialists regard these cells as the causes of these functions, while vitalists regard the functions as in some way independent of the structures, or even the remote causes of the structures. Neither of these

conclusions is justified by scientific evidence, for in the living state there are no functions without structures, nor structures without functions. When one undergoes change, so does the other. Use or disuse of a muscle is immediately associated with changes in its structure, but neither can be said to be the cause of the other.

It is when we come to consider the relations of structures and functions in the nervous system of man that this conclusion becomes most important and even revolutionary, for it means that there can be no touch or taste or hearing or vision without corresponding sensory protoplasm or sense organs, no protoplasmic or organic memory without the registry of certain changes in the protoplasm of cells, no associative memory without association tracts, no consciousness without the complicated reactions and interactions of many brain cells and their connections. And yet this does not signify that eyes precede and are the cause of vision, nor, on the other hand, that vision exists apart from eyes. It does not mean that the nervous mechanism is the cause of consciousness, nor that consciousness exists independently of the nervous system. But it does mean that they are indissolubly united.

This is the body-mind problem, or the relations and connections between mind and body. I am aware of the fact that this is a field which has been hallowed by the labors of hundreds of the world's greatest philosophers and scientists, and I can bring no original solution to this time-honored problem. But I can at least state an honest conviction, based upon an enormous volume of the work of investigators in biology, physiology, and psychology. So far as I am aware, no modern scientist has found any conclusive evidence of the existence of a mind apart from a body, no really satisfactory evidence of disembodied spirits,

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no scientific evidence in favor of Plato's conception that the relation of the soul to the body is that of the rower to his boat, or of the harpist to his harp. On the contrary, the most careful and detailed work in physiology and psychology shows that the relation between mind and body is that between function and structure. How else is it possible to interpret the facts of brain physiology, pathology, and experimental psychology? How else is it possible to interpret the facts of the parallel development and decay of body and mind?

5. INCREASE IN COMPLEXITY AND INCREASE IN EFFICIENCY

In the course of development, the generalized structures and functions of the egg become more and more specialized. Certain cells are specialized for digestion, others for motion, and still others for respiration, excretion, reproduction, and sensation, but every cell retains a residual trace of all these functions, which were present in the original egg cell and which are necessary to the life of every cell.

Groups of specialized cells form tissues and organs and systems which are able to perform specific functions better than individual cells. Thus differentiation of functions, as well as of structures, grows more complete and perfect as development progresses. This process of progressive differentiation consists in part in a separation and segregation into different cells of the general structures and functions of the egg, but mainly it is an actual increase or generation of specific structures and functions by the process of "creative synthesis" or "emergence." The egg in its development is not a self-contained and independent mechanism, and it would never undergo development except in response to environmental stimuli. These stimuli and the responses

they call forth modify the protoplasm, and these modifications enter into the actual structure and function of the developing organism, and so give rise to the increasing complexity of structures and functions.

But, while these processes would account for increasing complexity, they do not in themselves explain increasing perfection of structure and function, for mere complexity does not necessarily mean perfection. For example, perfection of vision means the efficiency with which visual organs receive and transmit to the central nervous system the stimuli coming from light rays. The compound eyes of arthropods are in many respects more complex than the eyes of vertebrates, but they are less efficient visual organs, as both physiology and physical optics testify. To explain increasing efficiency of vision, or of any other structure and function, in both ontogeny and phylogeny, it is necessary to recognize that there are ends to be attained, and that there are means or processes that direct development toward these ends.

Indeed, the moment we enter the living world, we enter a world of ends as well as of means, of finalism as well as of mechanism. So far as the physicist or chemist or astronomer can see, it makes no difference to an individual atom or molecule or planet or sun whether it continues to exist as such or not. But the biologist sees evidence that it apparently makes a difference to any living thing whether it continues to live or not. The great and universal end of living things is to continue to live, and numerous structures and functions are directed to this end. Indeed, the urge to live, the struggle for existence, is one of the most evident and universal phenomena of life. Apparently it is true of living things in general that,

'Tis life not death for which they pant,
More life and fuller that they want.

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In the attainment of these ends, efficiency of structures and functions are means, and in turn the perfecting of these means becomes ends. Indeed, we cannot deal with organisms logically without regarding them teleologically; in them we find both means and ends, mechanism and finalism.

It is one of the curiosities of modern biology that it goes to such extraordinary lengths to eliminate the idea of ends or purpose in the structures and functions of living things and even to deny them in the conscious experiences of human beings. It is sometimes held that words such as "ends," "purpose," "meaning," must never be used in science, and yet it is impossible to describe organisms fully without using these or other words that mean the same thing; many biologists get around this difficulty by inclosing such words in quotation marks, others speak of the "significance" or "import" or "tendency" of certain functions or processes, but by none of these verbal subterfuges are they able to get rid of the idea which lies back of all of them.

The fact is that organisms are fundamentally teleological, and although it may be impossible to explain this in a mechanistic or causal manner, this failure is no excuse for denying the reality of the phenomenon itself. It has been argued that ends exist only in the minds of intelligent observers, but the same could be said with equal cogency of means, causality, order, or nature itself. This is the view of radical philosophical idealism, but it is contrary to the fundamental concepts of objective science.

In commenting upon the fact that adaptations are mechanisms for securing the persistence of organisms, Roux¹ says: "Persistence is not an *aim* of living things but an indispensably necessary *condition*. Life cannot suddenly arise anew, but if it exists it must be preserved, and so must before all be capable of persisting, otherwise it disappears.

¹*Arch. Entw. Mech.* Bd. 26 (1908).

This is no *aim* but a direct necessity of its existence." But, after all, the real question is how living things are able to meet these necessary conditions of life. It may be granted that adaptations are not caused by conscious aims or purposes, but their results are much the same as if they were; they do attain certain desirable ends, and to this extent they are purposive.¹

Denial of ends or objectives in lower organisms must logically lead to its denial in man, if the main postulate of evolution be true, namely, that all life is fundamentally one. These ends or objectives are seen in the structures and functions of human germ cells, embryos, and adults, as well as in those of lower animals. The development of organs for future uses is not accompanied by conscious purpose, but it is none the less purposive. Who can witness the development of eyes which takes place in mammals in the absence of light, or the development of a hundred other organs for some future use, without recognizing that there are objectives toward which development is directed? If objectives exist only in the mind of the observer, then what ground is there for supposing that the mind of the observer or the observer himself has any real existence? Such views lead to intellectual nihilism.

The Darwinian principle of natural selection, or the elimination of the unfit and the "preservation of favored races in the struggle for existence," has been generally recognized as a purely mechanistic explanation of increasing efficiency or fitness in the course of evolution. This principle operates by the elimination of unfit individuals and races and the survival of the more efficient ones. It is merely a sieve to sort out individuals with favorable variations or muta-

¹E. G. Conklin, "Problems of Organic Adaptation," *Rice Institute Pamphlet*, Vol. 8, No. 4, Oct. 1921, pp. 365-366.

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tions from those with unfavorable ones, and given a continual supply of the former and a sufficiently thorough sifting, the less fit will be eliminated and the more fit will survive. This principle is purely mechanistic only in so far as it operates with no ends in view. But, from the standpoint of the organism, there is always to be considered the end of survival and increasing efficiency, and natural selection is merely a means to this end.

Darwin applied this principle to the increasing fitness of organisms to their environment in the course of evolution; but there are many such fitnesses which occur in the course of individual development, as well as in the mature organism, where there is no elimination of unfit individuals. Every embryo and every adult makes many adjustments to changing conditions which tend to its survival and greater efficiency, but which are accomplished without the elimination of any individuals. However, in such cases there is generally an overproduction of more or less random reactions to the new conditions, a gradual suppression of unfit or useless responses, and a persistence in making useful ones. Here is what seems at first sight to be a mechanistic explanation of fitness in the development and life-processes of the individual. But this is not strictly mechanistic, for the organism itself ceases to make useless or harmful responses, and persists in making useful ones; that is, it differentiates or distinguishes between the two. In the behavior of organisms this process of adjustment is known as "trial and error," and finally trial and success, but it is not entirely mechanistic, for in the elimination of certain responses and persistence in others there are always ends to be attained; trial and error is only a means to these ends.

In Darwin's theory, the environment is the eliminator of unfit individuals, and this process might be regarded as

purely mechanistic if one did not inquire why the environment and the organism are so related to each other that increasing efficiency of structure and function has resulted in the course of progressive evolution. A study of the relation of organisms to their environment shows that while the organism fits itself to its environment, the environment is remarkably fitted to the organism. The peculiar properties of water, carbon dioxide, and the carbon compounds in general, are uniquely suited to the origin and continuance of life as it exists on earth, and L. J. Henderson has said that there is not one chance in many millions that all of these peculiarly favorable conditions should have come about by mere chance. There is then a "fitness of the environment" for life as well as a fitness of life for the environment. From this larger aspect, organisms and environment are not independent but intimately related factors in evolution and development, and in both we see not only mechanism but also finalism. It is this appearance of teleology in all nature, this intimate connection and reciprocal interaction of means and ends, no less than the interrelationship of the objective and the subjective, that justifies the title of Bowman's book, *A Sacramental Universe*. Darwinism has discredited the supernatural origin of fitnesses, but not their reality; it controverts some of the arguments of Paley and the Bridgewater treatises, but not the underlying teleology of nature.

The recent death (April 18, 1941) of Hans Driesch, Professor Emeritus of Philosophy in the University of Leipzig, recalls his voluminous publications in support of a teleological principle in organisms. As a student he accepted the machine theory of life, but experiments on the eggs of sea-urchins and many other invertebrates convinced him that fragments of eggs could develop into whole animals. He maintained that the early cleavage cells were "like balls in

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a pile," and that each one of them was "totipotent," that is, it could develop into a complete animal. Consequently he rejected the mechanistic conception of life. He said it was impossible to conceive of any machine that could be broken up in the three dimensions of space, and the fragments be capable of producing whole machines. Furthermore the ability of many organisms to restore lost parts, and of all organisms to heal wounds, led him to the conclusion that there is something in living things that is non-mechanistic and non-causal, which something, following Aristotle, he called "entelechy." In the adaptive behavior of organisms he postulated a similar principle which he called "psychoid," and in other writings "soul."

It is now well known that the instances on which he first based his conclusion that isolated cleavage cells or fragments of eggs are all alike and totipotent are not strictly true. The cytoplasm of eggs and cleavage cells is differentiated more or less in different species, and this differentiation increases throughout development, but in every cell there is a nucleus which remains undifferentiated, and, when the cytoplasm is not too highly or too irreversibly differentiated, it may be reorganized under the influence of the undifferentiated nucleus.

There is here, and in all development, regeneration, and behavior, a material, causal basis for all these regulative phenomena, and in this sense they conform to a "machine-theory" of life, only the machine is much more complicated than Driesch supposed, for the vital machine includes undifferentiated nuclear machines inside differentiated cytoplasmic machines.

There is the best of evidence that mechanisms, that is, matter, energy, causality, are present in all vital phenomena, but there is also good evidence that in the living world at

least, and perhaps also in the lifeless, this mechanism is so constituted and directed that it leads to certain ends. Mechanism is universal, but so also is finalism. In my conception, the relation of mechanism to finalism is not unlike that of structure to function—they are two aspects of organization. The mechanistic conception of life is in the main a structural aspect, the teleological view looks chiefly to ultimate function. These two aspects of life are not antagonistic, but complementary.

6. PSYCHIC DEVELOPMENT

While survival is the chief end of living things, it is not to be assumed that this is in most organisms a conscious aim. On the contrary, there is no evidence that lower organisms are aware of any such aim. But the fact that all show differential sensitivity and reactivity, that is, attractions and avoidances, or positive and negative tropisms, seems to indicate a capacity to differentiate between that which is satisfactory and that which is the reverse. Tolman has recently designated such phenomena as "satiations" and "sufferances."¹

Satisfaction and dissatisfaction are subjective phenomena, and, as such, they are generally denied any place in objective science. But they are real phenomena, nonetheless, and must be taken into account in any attempt to explain the behavior of living things. Who can observe the behavior of an amoeba taking in certain food substances and rejecting others, following after and catching another amoeba, losing it and then catching it again, as Jennings has described, without concluding with him that if amoeba were as big as a dog we would think its behavior intelligent? Para-

¹E. C. Tolman, "Motivation, Learning and Adjustment," *Proc. Amer. Philos. Soc.*, 84, pp. 543-563 (1941).

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medium avoids extremes of heat or cold, salts and irritating substances, and comes to rest in masses of bacteria on which it feeds.

Even plants behave "as if" they derived satisfaction, as they certainly derive benefits, from certain movements. Shoots of germinating seeds persist in growing up toward light and air, and roots in growing down toward soil and moisture, even if often inverted or the movement blocked. Trees send roots long distances toward water-drains, growing potatoes in cellars send shoots many feet toward windows and light. Hundreds and even thousands of movements of organisms or of their parts show such phenomena of differential sensitivity and selective reactivity, moving toward certain sources of stimuli and away from others "as if" they experience satisfaction or dissatisfaction. No one doubts that this is true in human behavior, and all the evidences indicate that higher animals experience pleasure and pain, and attempt to secure the former and avoid the latter. No one knows how far down in the scale of life such feelings and motives are found, but certainly there must be some precursor of such feelings perhaps even in amoeba and also in germ cells of higher forms.

Jedes Thierchen hat sein Pläsierchen.

Yes, I know that all these phenomena are called tropisms and are supposed to be explained by that word, but this is mere nominalism and no real explanation.

In this connection it is interesting to recall that strict mechanists, such as the late physiologist Jacques Loeb, reject altogether the theory of trial and error. They recognize that it contains a psychic element which they think is inconsistent with their mechanistic conception of life, in which all behavior is fixed and machine-like. They hold that the activities of all protoplasm from protozoa to man

are "forced movements," without any choice or freedom. The denial of selective responses and choice seems to such mechanists an absolutely necessary conclusion from their basic premises. I recall a conversation which I once had with Loeb on this subject. After he had vigorously denied the reality or possibility of human freedom, he saw his little son running down the steps with a large open clasp knife in his hand. At once he shouted, "Bobby, close that knife. You might fall on it." I said, "Now Loeb, practice your philosophy," and in reply he merely winked one eye at me.

The fact is that no philosophy that denies a certain degree of freedom to man can be lived, and there must be something wrong with any philosophy that cannot be lived. Starting with the assumption that there are no elements or germs of the psychic life in protozoa, germ cells, and lower organisms, it is possible to reach the conclusion that there are no such phenomena in man. But if we reverse this process, and, beginning with those phenomena in man, which we know better than any and all others, try to find how far down in the animal kingdom we can trace the origin of these, we are following a safer procedure. This is precisely what every embryologist does in tracing the origin of developed structures, he works backward as well as forward in development—to the earliest traces of certain structures and then forward from these "anlagen" to the developed organ. In short, we should not leave man and his fully formed characteristics out of account in the study of development and evolution. From our human point of view, man is the measure and the measurer of all things.

The fear of anthropomorphism or "anthropism" (Sherington) has been carried too far in biology. We are told that we must not impute human experiences or faculties to subhuman organisms, and yet we are assured that man is

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kin to the animals and has evolved from them. We are taught that the human being is a colony of cells, each more or less like an amoeba, and that human characteristics are the combined results of amoeboid characteristics, new combinations giving rise by creative synthesis to new qualities. In short, we may interpret man in the light of our knowledge of amoeba, but we must not impute to lower organisms even the germs of human qualities; we must avoid "anthropisms" but not "amoebisms." Of course the truth here, as in all development, lies between the extremes of absolute epigenesis and complete preformation. Developed human characteristics are not found in germ cells nor in lower animals, but their germs or elements are found in all living things. To deny this is not only a denial of the kinship of man with animals, but it is a refusal to think logically and humanly, for how can we think at all except anthropically? Even mechanisms are conceived in the light of human machines.

The germinal elements from which man's mental life develops are found in all living things. But these mental germs must develop if they are to produce mind. As the body is not actually present in the germ, so the mind is not present in a developed condition in the germ nor in the lower forms of life. Differential sensitivity and selective reactivity, satiations and sufferances or satisfactions and dissatisfactions, are the protoplasmic or germinal beginnings of psychic phenomena, for ability to distinguish (or differentiate) between stimuli, and to select (respond positively) or reject (respond negatively), is the basis of behavior, and even of wisdom, wherever found. For what is wisdom, even in man, but this fully developed ability to distinguish and select? There is a wisdom of the body, as Sherrington and Cannon have emphasized, a wisdom in

meeting needs and crises, often equal to, if not greater than, that of human intelligence; and similarly there is a wisdom of every living thing from the simplest protoplasmic masses to man himself, from the germ cell to the adult, namely, the fundamental wisdom of life.

The illuminating studies of Coghill have shown that the behavior of the newt, *Amblystoma*, "develops from a primarily integrated total pattern of action and the individuation of partial patterns within the total pattern. . . . The nervous system concerns itself first with the integrity of the individual and only later makes provision for local reflexes."¹ This is typical of the whole course of differentiation, both physical and psychical. The general function of differential sensitivity, found in one-celled animals and plants in which the protoplasm is sensitive to many kinds of stimuli, becomes differentiated and segregated in special portions of the protoplasm, and then in the special sense organs which are especially sensitive to touch or vibration (hearing) or chemicals (taste and smell) or light (vision); and the differential reactions of the general protoplasm develop into the special reactions of organs for motion, ingestion, digestion, secretion, respiration, reproduction, reception and conduction of stimuli.

In the same way, the psychic elements of differential sensitivity and reactivity in the germ differentiate into those of the adult—tropisms and reflexes into instincts and habits (conditioned reflexes); organic or protoplasmic memory into associative memory; adaptive responses through "trial and error" into intelligence or the ability to learn by experience and reason, or ability to make general comparisons (generalizations); varied responses due to conflicting stimuli or

¹G. E. Coghill, "Early Development of Behavior in *Amblystoma* and in Man," *Arch. Neurology and Psychiatry*, vol. 21 (1929).

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physiological states into inhibition, choice, and will. In this whole process general psychic functions become more highly specialized, localized, and efficient.

All protoplasm responds to stimuli in specific ways, which are known as tropisms and reflexes. They are mechanistic responses showing relatively little variability. Simple reflexes like the contractions of an isolated muscle are, under constant conditions of muscle and environment, fixed and machine-like, but when connected with other parts of the organism the conditions are less constant and the response is more variable. In some of the earliest body movements of the human embryo before birth many muscles and nerves cooperate in the movements of head and trunk and limbs in response to stimuli. If the nose or mouth of a three month human embryo is stimulated by touching it with a camel's-hair brush, the head moves from side to side and the hands come forward to ward off the brush. These movements are purely mechanistic, and their complicated patterns and successions are determined by the inherited organization of the embryo. After birth, the complexity and number of such responses greatly increases; simple reflexes are connected together in series, one reflex following another in some complicated act. For example, stimulation of the lips of the new-born infant causes numerous muscles to contract in a definite sequence, resulting in the act of sucking and swallowing. The numerous reflexes involved in this act are connected together like links in a chain. The whole response is machine-like and is inherited along with the muscles and nerves. When such a chain of inherited reflexes is long and involves many muscles and parts, it is often called an instinct. The acts of sucking and crying in the infant are instinctive. They are at first purely mechanistic, but gradually they tend to lose this machine-like

character and become more variable. The stimulus to the lips may not induce the sucking reaction, but an avoiding one; other conflicting stimuli, or the physiological state of the stomach, may be responsible for this change. The behavior of the embryo is more fixed and automatic than that of the baby, and throughout development there is an increase in the plasticity and variability of behavior which goes hand in hand with the increase in complexity of organization, interaction of parts, and number and variety of stimuli. But there is no evidence that action of any kind ever takes place in the absence of external or internal stimuli; so-called automatic acts are those resulting from internal stimuli.

Enormously long and complicated chains of reflexes occur in all animals in connection with the conservation of the individual and the perpetuation of the race. Nowhere is behavior more complicated than in relation to sex and reproduction. From the relatively simple reactions of spermatozoa and egg cells to the enormously complicated reactions of males and females by which the germ cells are brought together; from the behavior of individual cells to the psychology of parents in courtship, mating, nest building, feeding and protection of the young, we find in the animal kingdom some of the most remarkable of all chain reflexes. Many insects and lower animals perform these complicated acts but once in their lives; they have no chance to learn them by practice or imitation; they are as perfect and automatic as the form of the organism itself, and they must therefore be inherited. These are undoubted instincts, complicated chain reactions that are relatively fixed and automatic.

In higher animals and especially in man these chains of reflexes are less rigidly fixed than in insects and are more

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capable of improvement by practice. New chains of reflexes may be set up by bringing about new connections of links and chains, or, more accurately speaking, new paths of conduction in the nervous system. Such are the "conditioned reflexes" of Pavlov and the "habits" that may be established by training and practice in higher animals and man. All such complicated acts as learning to walk and talk and play games are such conditioned reflexes or habits. They are not inherited instincts, only their potentialities in the organization of muscles and nerves are inherited, and the uses to which these organs are put are determined by practice, that is, by selection from among many possible reactions those which are most satisfactory, and elimination of the others, in short, a process of trial and error, and finally trial and success.

This ability to establish new habits and in general to learn from experience is one of the most characteristic properties of man. It is unquestionably associated with the greater "plasticity" of his organization, which probably means the greater number of nerve cells and fibers and association tracts in his nervous system, and consequently the greater number of paths that may be broken through this complicated system.

Another fundamental property of protoplasm in general is a basal form of memory. The effects of a previous stimulus are in some way stored in the protoplasm for a shorter or longer time, and are added to the effects of a subsequent stimulus. This is known as "summation of stimuli." In the insectivorous plant known as the Venus Fly-trap, a single stimulus of the sensitive hairs on the leaf causes no movement, but a second stimulus within a period of about three minutes springs the trap and causes it to close. Evidently the effect of the first stimulus is retained in the cells of the

mechanism for about three minutes, after which it passes away. Similarly the protoplasm of a muscle or nerve or gland cell retains for a time the effects of previous stimuli. This is protoplasmic or "organic memory" (Herring). Its effects are strikingly seen in the training of muscles and nerves of a child to perform accustomed acts, such as walking, talking, playing games.

Just as complicated instincts and habits develop out of simple tropisms and reflexes, so intelligence and reason develop out of adaptive or useful responses, which in turn are the results of trial and error, that is, the persistence of the fit. This persistence in the performance of useful acts and the avoidance of useless ones is in animals with nerve centers the result of associative memory. Any animal that can learn anything, such as the association of particular stimuli with particular results, e.g., a call or the ringing of a bell with the offer of food, has associative memory. Such memory is found only in animals with complicated nervous systems and association tracts between sensory and motor centers.

It would take us too far afield to undertake here a review of the intelligence, social organizations, communications, and cooperations of animals, but there is no doubt among those who are well acquainted with the subject that all of these characteristics are found among animals below man. And yet they are slightly developed as compared with man, and there is still less evidence of self-consciousness, introspection, and reasoning in animals, although, as Huxley once said, nothing short of becoming a crayfish would reveal what a crayfish feels and thinks.

By general agreement among students of animal psychology there are few signs of the ability to generalize or reason among even the higher mammals. There is no doubt

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that they are often intelligent, that is, they can learn by experience to do useful or desirable things. A burnt cat as well as a burnt child dreads the fire, and a horse can learn to lift a latch and open a gate or door and in this one respect is intelligent, for intelligence is the ability to profit or learn by experience. But Thorndike found that cats that had learned by trial and error to open a door by turning a button were quite unable to turn this intelligence to a different kind of fastening, such as the lifting of a latch; they had to go through the slow process of learning by trial and error how to lift the latch. A child would have to go through the same process, but it would make fewer errors and learn faster because it would soon get the *idea* of resemblance in structure or function between a button and a latch, that is, it would begin to *generalize*.

It is this capacity of generalization, which is the basis of all reasoning, and which is so little developed in animals as compared with man. Comparisons of resemblances and differences are fundamental in all intelligence and reasoning. In the lowest stages of intelligence, resemblances must be very close, amounting almost to identity, to be recognized, the latch and door must be very similar to the ones already learned to permit the extension of previous experience to the new latch and door. With the growth of intelligence, comparisons between objects or events that are less and less alike become possible. Such resemblances or differences range all the way from practical identity through similarity to complete dissimilarity. Thus the faculty of generalization and reasoning is born, and thus the scientist and philosopher can compare the mental resemblances and differences between animals and man.

Inhibition, choice, and will undergo natural development in both phylogeny and ontogeny. In the words of Professor

C. O. Whitman, "Choice is not . . . a little deity encapsuled in the brain. . . . But increased plasticity invites greater interaction of stimuli and gives more even chances for conflicting stimuli." The will is the ability to use as internal stimuli the results of previous experience and "the freedom of the will" is directly proportional to this ability. Our freedom is measured by our intelligence and our ability and desire to use it as stimulus or inhibition.

In all animals behavior is modified through previous experience; where several responses to a stimulus are possible, and where experience has taught that one response is more satisfactory than another, action may be limited to this particular response not by external compulsion but by the internal stimulus of experience and intelligence. This is what we know as choice or will. Freedom of action does not mean action without stimuli, but rather the introduction of the results of experience and intelligence as stimuli. The activities which in the lower animals are "cabined, cribbed, confined" reach in man their fullest and freest expression; but the enormous difference between the relatively fixed behavior of a protozoan or a germ cell and the relatively free activity of a mature man is bridged not only in the process of evolution, but also in the course of individual development. . . .

The most complex of all psychic phenomena, indeed the one which includes many if not all of the others, is consciousness. Like every other psychic process this has undergone development in each of us; we not only came out of a state of unconsciousness, but through several years we were gradually acquiring consciousness by a process of development. Whether consciousness is the sum of all the psychic faculties, or is a new product dependent upon the interaction of the other faculties, it must pass through many states in the course of its development, stages which would commonly be counted as unconscious or subconscious states, and complete consciousness must depend upon the complete development and activity of these other faculties, particularly associative memory and intelligence. . . .

Finally, there seems good reason for believing that the continuity of consciousness, i.e., the continuing sense of identity, is associated with the continuity of organization, for in spite of frequent changes of the materials of which we are composed our sense of identity remains undisturbed. However, the continuity of protoplasmic and cellular organization generally remains undisturbed throughout life, and the continuity of consciousness is associated with this continuity of organization, especially in certain parts of the brain. It is an interesting fact that in man, and in several other animals which may be assumed to have a sense of identity, the nerve cells, especially those of the brain, cease dividing at an early age, and these identical cells persist throughout the remainder of life. If nerve cells

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continued to divide throughout life, as epithelial cells do, there would be no such persistence of identical cells, and one is free to speculate that in such cases there would be no persistence of the sense of identity.

Organization includes both structure and function, and continuity of organization implies not only persistence of protoplasmic and cellular structure but also persistence of the functions of sensitivity, reflexes, memory, instincts, intelligence and will; the continuity of consciousness is associated with the continuity of these activities as well as with the structures of the body in general and of the brain in particular. It is well known that things which interrupt or destroy these functions or structures interrupt or destroy consciousness. Lack of oxygen, anaesthetics, normal sleep cause in some way a temporary interruption of these functions and consequently a temporary loss of consciousness; while certain injuries or diseases of the brain which bring about the destruction of certain centers or association tracts may cause permanent loss of consciousness.¹

7. SOCIAL AND MORAL DEVELOPMENT

All development is the result of the interaction of heredity and environment, and the germ changes into the adult only in response to environmental stimuli. The effects of these stimuli and responses are registered in the organism, and persist there for a longer or shorter time. In the analysis of the processes of development of the body as well as of the mind the "creative synthesis" brought about by the interaction of organism and stimulus has been too much neglected. Biologists generally regard the organism as all-important, the stimulus as relatively unimportant. For example, many kinds of stimuli may cause a muscle to contract, and this has led to the prevalent view that the stimulus merely sets off a reaction already prepared for in the organism, that the stimulus is like the spark in the gunpowder and nothing more. But the living machine is not altogether that kind of a machine, for the stimulus not only sets off the explosion, but its effects persist for a longer or shorter time in the surviving mechanism. A muscle or nerve that has been stimulated is not the same as it was before, as is shown

¹E. G. Conklin, *Heredity and Environment* (1923), pp. 52-54.

by all phenomena of after-effects, training, and organic memory. In short, the effects of stimuli, even in the simplest physiological responses, enter into and modify the responding organism.

This is more evident in the responses of entire animals and plants than in their individual parts. Even in protozoa responses are modified after repeated stimuli, and usually in beneficial ways.¹ "Summation of stimuli" in plants and animals means that some more or less lasting change is caused in the protoplasm by the stimuli. All protoplasmic or organic memory, such as is found in the training of muscles and nerves in learning to walk or talk or play games, means that the protoplasm is changed in reacting to stimuli. All learning, all profiting from experience, means that the organism is modified in specific ways by its responses to particular stimuli.

Human development is especially influenced by environment. In addition to the physical and chemical environments, which all organisms share, man is subjected to potent intellectual and social environments. Intellectual, emotional and social stimuli and responses leave more or less lasting effects on the person. In this sense all of us can say with Ulysses "I am a part of all that I have met," and conversely, "All that I have met has become a part of me." It is in this sense that we are "heirs of all the ages," for our social environment has entered into our development and has become a part of our very selves.

The unknown individual or tribe that first learned the uses of fire and how to conserve or produce it, the person who first made a stone hammer or spear, or first learned the uses of a lever or wedge or wheel, the tribe that first learned the uses of metals or how to harden copper or smelt iron from the ore—all these contributed to the physical, psychical,

¹H. S. Jennings, *The Behavior of the Lower Organisms*.

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and social environment in which we live, and this environment has entered into the making of our personalities. In like manner, the development of articulate speech, the devising of graven or written characters as symbols for ideas and words, the invention of a phonetic alphabet, as well as of paper, printing, the telegraph, the telephone, the radio, and a thousand other discoveries and appliances—all these have created an intellectual and social environment which has not only influenced our development but has also become a part of our very selves.

Similarly, the thoughts, emotions, and ideals of our fathers and mothers and friends and teachers—more than all perhaps their very characters—have become a part of us. Concepts of right and wrong, of honor and loyalty, of devotion and patriotism, of altruism and religion, were not born with us but have entered into us through our social environment. Also selfishness and cruelty, fear and hate, aggression and pride, are not primary and inherited reflexes or instincts, but are largely conditioned reflexes—often inculcated and perpetuated by associates, teachers, and leaders. Our social and ethical environment is more potent in shaping our ideals of cooperation and conflict, of right and wrong, than inheritance through the germ cells.

Heredity, or the germ-plasm, determines only the capacities and potentialities of an organism. In every individual there are many capacities that remain undeveloped because of the lack of suitable stimuli to call them forth. These inherited potentialities are both good and bad, social and anti-social, and it is the purpose of good education to develop the former and suppress the latter. To trust wholly to germ-plasm is to forget that heredity furnishes capacities for evil as well as for good, and to disregard the universal experience of mankind.

Personality is the product not only of heredity but also of

environment. We are the children not only of our parents and more distant ancestors from whom we have received our chromosomes, but also we are the intellectual, social, and spiritual children of all those persons whose ideas, ideals, and examples have entered into the making of our characters. The development of our mental and moral characters is the product of heredity and environment, much of it far removed from our personal control. But with the birth and growth of intelligence, inhibition, and will, some of the environmental influences and internal motivations come under our control and thus we become "free moral agents."

But do the soul and spirit of man undergo natural development as the mind and body do? With most persons there is need of clearer definitions of what is meant by these words. For the prevalent view is that soul and spirit are breathed into the body by supernatural creation. But scientists generally maintain that these also are products of natural development. Some extremists hold that they are mere words having no factual existence; all admit the reality of body and mind and some maintain that these constitute the whole man. But this would involve assigning to body and mind the emotions, aspirations, and ideals of men, together with their social, ethical, and religious impulses and responses. One definition of soul is, "A substantial entity believed to be that in each person which lives, feels, thinks and wills," i.e., the "anima" or life. A second definition is, "The moral and emotional part of man's nature; the seat of sentiments and feelings in distinction from intellect."¹ From the scientific point of view the second definition is preferable to the first, but biological science does not admit that body and mind and soul are distinct and separable

¹Century Dictionary.

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entities. They are different aspects of one organism, as structure and function are, and they are not separate or separable. Likewise the word "spirit," has many different meanings, ranging all the way from breath, vapor, essences and alcohol, to ghosts or "gaseous vertebrates" and to supernatural beings. But as applied to man, its meaning, in scientific usage, is character, temperament, essential nature.

In the days before there had been much study of comparative and genetic psychology there were scientists, like Alfred Russell Wallace, who were strong defenders of the natural evolution of man's body, but believed that mind and soul came by supernatural creation. Today there are few if any anthropologists, psychologists, or sociologists who take this view. The evidences in favor of mental and emotional, social and ethical, evolution and development are as cogent as those in favor of physical evolution and development. However, there are still many half-way evolutionists among non-scientists who admit evolution of the body, but deny it to the mind and soul.

Before there was any knowledge of the early stages of human embryology it was generally held that "about forty days after conception life enters the embryo from the outermost sphere of the Ptolemaic Universe" (Sherrington), and that soul as well as life was first imported into the embryo when it began to move or was "quickened." Many religious beliefs and legal prohibitions are founded upon this antiquated doctrine. The transmigration of souls from dying men or animals to the new human being has been taught in the philosophy and religion of many lands. All such beliefs are completely discredited by modern science.

The initial origin of the Hominidae was probably a million or more years ago, and there is necessarily much speculation as to the precise manner and means of that

origin, but the origin of individual human beings here and now is a present and everyday process. There is every evidence that the body, mind, and soul develop by natural processes from the human germ. Those who assume a supernatural origin of the mental and moral qualities of an infant or child might reasonably be expected to indicate when and where in the course of development this supernatural creation or intervention occurs. There is no evidence at any point in development of the supernatural introduction of life, mind, or soul nor of any supernatural interference with natural processes.

This is no more old-fashioned "materialism" than it is "psychism," for it endows all protoplasm with the elements or germs of the psyche, perhaps all matter and energy with "the promise and potency of life." In some respects it is akin to the monadology of Leibniz or the pan-psychism of Thomas Carlyle, Fechner, and Paulsen. On my part it is an honest attempt to account for the development of the entire personality in accordance with scientific evidence. Physiologists and bio-chemists frequently assert that life and all its properties, including human consciousness, purpose, and ideals, are purely and solely physico-chemical problems (*vide* Loeb, Hogben, Sherrington, *et al.*); or they attempt to show that these psychical experiences are not real (e.g., J. B. Watson, *et al.*) But to deny the reality of subjective phenomena is equivalent to denying the reality of all phenomena, even the objective, for the latter can be apprehended only by means of the former. If the germs of life, mind, and soul are found in physico-chemical processes, we have merely endowed molecules, atoms, and electrons with these potentialities. It should be the aim of proponents of the "mechanistic conception of life" to show that psychic and subjective phenomena in general are germinal or potential in matter and energy, for subjective phenomena are

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realities, even though some of their contents, such as fantasies, are not, and it is only through subjective experiences that we become aware of the objective world.

This is neither the time nor place to deal in detail with many aspects of genetic psychology and sociology, but for present purposes it is sufficient to indicate that the entire human being—body, mind, and soul—develops by a process of progressive differentiation from the structures and functions of the germ cells in response to physical, mental, and social stimuli. Those who deny such development do not and cannot rest their case upon scientific evidence. So far as I can see, the only rational and scientifically defensible method of maintaining divine control over the evolution of man and the development of individuals is to assume that back of all development and evolution, back of all biology and chemistry and physics—indeed throughout all nature—is divine immanence.

On a July day in 1868, John Tyndall, the English physicist, who was also a great mountain climber, sat on a crag of the Matterhorn, and thinking of the molten state from which it came, and of the star dust from which the molten world originated, asked himself whether that primordial fog contained potentially the feelings with which he regarded the Matterhorn.¹ We may answer that in accordance with universal evolution those feelings were born not only from primordial matter, but also from all the energies and conditions that had acted on that matter through countless ages. New combinations of elements had given rise to new chemical compounds with entirely new properties in accordance with the universal principle of creative synthesis, emergence, or creative evolution. Environment had entered into the formation of that granite and into all the processes that had led to the origin of life. And in the bil-

¹"Musings on the Matterhorn, 27th July, 1868."

lion years of organic evolution, environment had entered into the countless creative syntheses which culminated in man. And in the development of Tyndall, physical, intellectual, social, and spiritual environment had entered into the formation of his mind and emotions, so that he was the product of all that had gone before.

This does not imply that the characteristics of human personality are found in all nature, but it does indicate that the *potentialities* of all that has come out of the evolution of matter, of worlds, and of man were in the original constitution of the universe and its later transformations. How those potentialities got there no one knows, why the environment was such as to bring about those transformations is unknown; the theist attributes them to God, the atheist to Chance, the scientist to Nature, and the realist may attempt to synthesize all of these concepts. The germinal potentialities of all development must be in at the beginning or must be added later. In the development of every living thing, two distinct factors are necessary, the original constitution of the germ and the particular environments that act upon it. The egg contains the germs of functions as well as of structures of the psyche as well as of the body.

Those who seek for the causes of the mental and spiritual qualities of mature persons will not find them in the matter of the germ cells alone, but also, and chiefly, in mental, social, and spiritual environment. Such environment is acting on every child during its development, and thus mental and moral qualities develop through contact with persons possessing those qualities; and in later years through the precepts and examples, the ideals and inspirations of all whose words and deeds have become a part of our social and spiritual heritage. In this way nature (or God) works through human agencies in the development of intellectual, social, and spiritual qualities in man.